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Examiners' Report

Summer 2014

Pearson Edexcel GCE in Core Mathematics 2 (6664/01)

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General Introduction

This paper proved a good test of students' knowledge and students' understanding of Core Mathematics 2 material. There were plenty of accessible marks available for students who were competent in topics such as binomial expansions, integration, geometric series, trigonometric equations and differentiation. Therefore, a typical E grade student had enough opportunity to gain marks across the majority of questions. At the other end of the scale, there was sufficient material, particularly in later questions to stretch and challenge the most able students.

While standards of algebraic manipulation were generally good, some weakness in this area was seen in Q03(b) and Q06(c). Work on indices was sometimes problematical and a significant minority of students in Q04 incorrectly wrote $\frac{1}{3x^2}$ as $3x^{-2}$ and many students were unable to deal with the work required in Q06(c), often writing $20\left(\frac{7}{8}\right)^N$ as $(17.5)^N$.

Report on Individual Questions

Question 1

This was an accessible first question; the trapezium rule seemed to be well understood by the majority of students and most answered it very well. In Q01(a) some students lost the mark for giving the missing value as 1.6 or 1.600, although this did not stop them from being able to gain full marks in part Q01(b).

A common error in part Q01(b) was to use 0.2 as the width of each strip, using the number of ordinates rather than the number of strips. Others misinterpreted the strip width from its definition in the formula book. Most students clearly showed the correct structure of the y values but there was omission of brackets. It was common to see expressions such as

$$\frac{1}{2}\times\frac{1}{4}(1.414+2.236)+2(1.601+1.803+2.016)$$

which led to the wrong answer. If subsequent working indicated that the correct bracketing was intended this lapse was condoned, but this was usually not the case. Occasionally the method mark was lost by including an extra term in the second bracket.

Question 2

This question was well attempted by most students, with the majority of students able to score 5 or 6 marks. In part Q02(a) most showed that $\mathrm{f}(2)=0,$ but a large number did not write a conclusion and so lost the second mark. A number of students who ignored the rubric and used long division in this part of the question, lost both marks.

In Q02(b) most achieved the correct quadratic expression, either by long division or inspection. A small number equated coefficients with $(x-2)(Ax^2+Bx+C)$, usually doing so correctly. Most students then went on to factorise the quadratic successfully, usually by inspection and a small number used the quadratic formula, but this did not always lead to the correct factors. A few students neglected to show the full factorisation of $\mathrm{f}(x)$, after factorising the quadratic, and so lost the final mark.

Question 3

The majority of students scored well in Q03(a), with many scoring all four marks. The most successful approach was to use the formula for expanding $(a+b)^n$. With this method the most common mistakes were forgetting to include the negative sign when using $3x$ (yielding $+576x$) and forgetting to square the coefficient of x in the third term (producing $720x^2$). Some students lost the final A mark due to leaving "$+-576x$" un-simplified. Pascal's triangle was not used very often. A smaller number of students tried taking out a factor of 2 from the bracket, however it was quite common for these students to forget to raise this to the power of 6. Those making this error could score a maximum of 1 mark for Q03(a). Those who took this approach, then had problems dealing with $\left(1-\frac{3x}{2}\right)^6$ and made errors in squaring $\left(-\frac{3x}{2}\right)$.

Students generally found Q03(b) more challenging and many students were let down by weak algebra. Many appreciated that they had to multiply their answer to Q03(a) by $\left(1+\frac{x}{2}\right)$ and earned the M mark, although they then sometimes did not try to simplify their answers. For those who did multiply $\left(1+\frac{x}{2}\right)$ by their expansion from Q03(a), the majority were accurate in multiplying out the brackets but a lack of proficiency in algebra let some down in this part. Loss of accuracy marks here also resulted from an incorrect expansion from Q03(a). A significant number of students did not collect up their like terms after expanding. Interestingly, those who listed their expansion in part Q03(a) were far more likely to leave their new expansion un-simplified. Good presentation aided students to collect like terms effectively after the multiplication. A few students tried to expand $\left(1+\frac{x}{2}\right)^6$ and multiply this by their answer to Q03(a). Another error that was seen occasionally was to expand $\left(1+\frac{x}{2}\right)(2-3x)$ and then to raise the answer to the power 6.

Question 4

Many students found this question fairly challenging.

The majority of students could successfully integrate $\frac{x^3}{6}$ and un-simplified expressions such as $\frac{x^3/6}{4}$ were accepted although this was sometimes simplified incorrectly as $\frac{2x^4}{3}$.

Integrating the second term caused greater difficulties however. It was fairly common for students to rewrite the second term incorrectly as $3x^{-2}$ and then to integrate to get $-3x^{-1}$. Some then wrote this as $\frac{-1}{3x}$ but by then the error had already occurred and recovery was not possible.

A few students tried to change the function prior to integrating, for example multiplying the expression by x^2 to give $\frac{x^5}{6}+\frac{1}{3}$ which presumably, they were far more comfortable integrating. Another error that was sometimes seen was to integrate both the top and bottom, so that $\frac{x^3}{6}$ was integrated to give $\frac{x^4/4}{6x}$ and $\frac{1}{3x^2}$ integrated to give $\frac{x}{x^3}$. Some students confused powers and denominators, changing $\frac{x^3}{6}$ to x^{3-6} and then integrating x^{-3}.

Having attempted the integration, most students were able to handle the limits correctly, with only a few adding the two results after substituting $\sqrt{3}$ and 1 instead of subtracting them or subtracting them the wrong way round. Many students however then struggled to get the correct final answer. Some left their answer as $\frac{6-\sqrt{3}}{9}$ despite the demand for the form $a+b\sqrt{3}$. Others made errors manipulating the surds. A surprising number of students did no integration at all and simply substituted in the limits, which gained no marks.

Question 5

Q05(a) was well attempted with the majority of students getting the correct answer. Where errors were seen it was commonly the use of $\frac{1}{2}r^2\theta$, $\pi r^2\theta$, or $r\theta$ for the sector area, though occasional miscalculations from a correct formula did occur.

In part Q05(b) most responses correctly used the cosine rule but identification of the correct angle was more problematic. Students sometimes used $\angle BDC$ and others $\angle BCD$. In such cases many students did realise the angle they were finding, and went on to find the area of BCD correctly in Q05(c), sometimes also recovering 0.943 when they proceeded to find the area of EAB. Truncating too early was not uncommon in such cases.

Where errors in the cosine rule were made it was usually due to mixing up the side lengths. A few students correctly reached the value of $\cos(DBC)$ but then failed to use inverse cosine to find the angle. A few instances of sine instead of cosine were seen.

Many students worked in degrees and converted to radians, mostly successfully. A handful of responses rounded to 0.94. Responses where the obtuse angle (2.198…) was found were uncommon. A notable other fairly common incorrect attempt was in assuming $\angle ABE$ was $\frac{\pi}{4}$ and using $\angle DBC = \pi - \frac{\pi}{4} - 1.4$

In Q05(c) the area of BCD was very well done. A few students incorrectly used 6.1 instead of 7.5. As noted in Q05(b), there were not infrequent attempts where one of the other angles had been found in Q05(b) but was used correctly in Q05(c) for this mark.

The angle $\angle EBA$ was mostly found correctly but some responses used $\frac{\pi}{2}$ or $\frac{\pi}{4}$ or even 2π instead of π. A common error was the assumption that triangle ABE was a '3, 4, 5' triangle based on its hypotenuse being 5 cm. Again, some students used degrees and converted to radians but not always correctly. A variety of methods were used to attempt to find the side lengths needed for the area of EAB with roughly equal proportions of each. Some found the third angle in the triangle and used the sine rule twice. Some attempted a 'hybrid' solution with a mixture of degrees and radians, with expressions such as $\frac{5}{\sin 90} = \frac{AE}{\sin(0.798...)}$ being used, leading to a common error of $EA = 4.004$. When this was followed by attempts at Pythagoras then no marks could be gained, though a few students did pick up the method for including $5\sin(\pi - 0.798)$ as part of their expression for the area of EBA.

Once the side lengths had been found, most, went on to find the area of EBA using a correct method. Errors causing the loss of this mark included use of an incorrect Pythagorean identity to find the third length, mixing degrees and radians (as noted above) and use of area = $b \times h$ for the triangle.

Rounding too early to obtain 39.0 as their final answer caused several students to lose the final accuracy mark. The method marks, however, meant students who made a numerical mistake were not overly penalised.

Question 6

Q06(a) was done very well with nearly all students obtaining the correct answer.

Q06(b) was also attempted very well. A few students made errors evaluating their answers and some used an incorrect sum formula such as $\frac{a\left(1-r^{n-1}\right)}{1-r}$ and some mistakenly used $n=20$, which cost them both marks in this part. A few students used the formula ar^{n-1}, thereby finding the 12th term instead of finding the sum. It was rare for students to try to find the sum by finding each of the 12 individual terms and then adding. Occasional truncation errors lost the A mark.

Fully correct solutions to Q06(c) were uncommon. Although the majority managed to earn the first method mark, not many of the students could deal with the inequalities. It was common for students to write $20\left(\frac{7}{8}\right)^N$ as $(17.5)^N$ or to take logs prematurely. Of the students able to get as far as $\left(\frac{7}{8}\right)^N < \frac{1}{320}$, most were able to take logs to reach 43.2. However, not many students managed to achieve the final accuracy mark, either because of errors with their inequality signs or because they gave their answers as $N = 43.2$ or $N = 43$. Many failed to realise that $\log\left(\frac{7}{8}\right)$ is a negative number and therefore did not reverse the final inequality when dividing through by this. This left them with $N < 43.2$ as their solution, even though they went on to state $N = 44$.

Some students used trial and improvement in Q06(c). Although many of these reached the answer $N = 44$, insufficient working often meant that full marks were not awarded. Some students, for instance, failed to consider both S_{43} and S_{44} and others over-rounded their answers, thus being unable to show $S\infty - S_{44}$ was actually less than 0.5.

Question 7

In Q07(i) most students achieved the first M1, though a minority expanded $\sin(\theta+60)$ as $\sin\theta+\sin 60$, which was the main reason that this mark was lost. Generally, most students did proceed to find a correct solution for the equation, with $326.4°$ being the more common of the two. In many cases this arose from adding $360°$ to (their $\alpha-60°$), with the second solution either not considered at all or attempts at $180°$ – (their $\alpha-60°$). Adding $60°$ instead of subtracting was also occasionally seen, with no evidence of correct use of $\theta+60°=...$ first. Some students tried to obtain more solutions by adding 90 degrees and thus lost the last mark despite having correctly found the two genuine solutions.

In Q07(ii) the major problem was the identity for $\tan x$. Students sometimes incorrectly quoted $\tan x=\frac{\cos x}{\sin x}$ or replaced $2\tan x$ with $\frac{2\sin x}{2\cos x}$, leading to the loss of all but potentially the final *B* mark, and it was a rarity for this to be gained in such cases. Students are advised to state identities of this type before attempting to apply them. Even where the correct identity was used, solutions were frequently lost by dividing through by $\sin x$. Some who quoted $\sin x=0$ after factorising correctly, failed to find both solutions 0 and $-\pi$. In many cases no solutions to $\sin x=0$ were seen. Correctly obtaining $\cos x=\frac{2}{3}$ proved more troublesome than might be expected. There were some interesting attempts including squaring, obtaining an equation in $\sin^2 x$ or $\cos^2 x$, the latter often leading to a correct solution. Some were not able to proceed further, or used incorrect identities such as $\cos x=1-\sin x$. Mostly these were unsuccessful with students getting lost in the algebra. In the few cases where they did get to $\sin x=\frac{(\sqrt{5})}{3}$, the negative possibility was missing and no appreciation of the extra answers generated were shown. Students who did get to $\cos x=\frac{2}{3}$ were often not able to go on to get both correct answers from this equation, with 0.84 and $2\pi-0.84$ the ones often given. Occasionally $\pi-0.84$ was given as the second solution. Some students chose to work in degrees and then convert to radians at the end.

The final B mark for the solutions to $\sin x=0$ was only scored by a small proportion of students, with most students who reached a solution having done so by dividing through by $\sin x$. Even in cases where $\sin x=0$ was quoted after factorising their equation, many then ignored it, or only gave 0 and π as the solutions. Overall, there were very few completely correct responses to this part. But those that were completely correct were often very well answered and presented.

Question 8

Many students scored full marks for the graph in Q08(a) but a wide variety of graphs were seen. Negative exponential graphs, the reciprocal function, parabolas and straight lines were fairly common. Some were very close to the *x*-axis, making it difficult to see if there were crossing or not and others appeared to have been erased and/or smudged which made them difficult to read. Mistakes were usually due to the curve passing through 3 on the *y*-axis, stopping at the *y*-axis or crossing the *x*-axis.

A number of students did not even attempt the graph in Q08(a) but did go on to make an attempt, sometimes successfully, in Q08(b)

Q08(b) was well answered by the majority of students. The use of $y = 3^x$ leading to a quadratic in *y* was the most common approach with letters other than *y* used occasionally. $x = 3^x$ was also frequently seen. Direct factorisation in e^x was less common. Once the quadratic was identified there were very few cases of incorrect solutions but there were a number of students who stopped at the point of solving the quadratic and did not go on to find values for *x*. The most common errors in this part of the question were in attempting to use logs e.g. $2x\log 3 - x\log 27 + \log 18 = 0$ or forming the quadratic $3y^2 - 9y - 18 = 0$. Many students believed that $9\left(3^x\right) = 27x$.

Question 9

Many students found this question challenging.

In Q10(a), many students did not appreciate that triangle OTQ was right-angled and so did not know where to start. Some of these unsuccessful students tried to work out the gradient of the tangent or tried to expand the general equation of the circle. Others assumed triangle OTQ was isosceles. Most students who did make use of the right angle at OTQ were able to reach $OQ = 14$ and then often went on to score full marks in Q10(a), although some could not square $6\sqrt{5}$ accurately (30 was popular). Some tried to find $\left[(6\sqrt{5})^2 - 4^2\right]$. A small number of students used trigonometry to find a missing angle in triangle OTQ and then went on to find $OQ = 14$ and $k = 5\sqrt{3}$.

In Q09(b) many students scored the method mark for forming an equation of a circle using their value of *k* (or just the letter *k*), but some were reluctant to use *k* in their equation for the circle and left a gap instead $\left(x-11\right)^2 + \left(y- \quad\right)^2 = 16$. Some students did not know the correct form for the equation of the circle, for example quoting $\left(x-a\right)^2 - \left(y-b\ \right)^2 = r^2$ or $\left(x-a\right)^2\left(y-b\ \right)^2 = r^2$, and some forgot to square one of the brackets or the radius. Another error was for students to mix up the 11 and *k* giving the equation as $(x-k)^2 + (y-11)^2 = 16$

Question 10

This question involved several different areas of work, area, volume, algebraic manipulation and calculus, and although a significant number of students produced clear and well-structured solutions, this proved a taxing question for many students.

Q10(a) was found to be challenging, with many students struggling to find the volume of the prism despite there being several possible methods. It was common to see $30x^2y = 9600$ derived with unconvincing or incorrect working, despite often being able to find the area of a trapezium correctly in Q10(b). Some students, realising that $30x^2$ must be the area of the trapezium, just used $6x \times 5x$. In Q10(b) there were many concise, correct and clearly set out solutions but it was very common to see several attempts and much crossing out, and extra terms slotted in at a late stage, presumably influenced by the required expression being given. Common errors included not finding areas of all 6 faces, finding too many areas, and combining dimensionally incorrect areas.

Almost all students who attempted the question gained marks in Q10(c) with most differentiating at least one term correctly and many achieving the correct S and setting it equal to 0. Many, though, found it difficult to manipulate their equation correctly and of those who reached $x^3 = 64$ many did not find $x = 4$. Common answers were $x = \pm 4$ or $x = 8$ Many lost the last two marks by not realising that they had to use *x* to find the corresponding minimum value of S.

Q10(d) was generally well attempted, even by those who did not complete Q10(c), with the majority remembering to compare S″ with 0. However, an incorrect S″, which was quite common even for those with the correct S′, did lose the final mark. A relatively small number of students set S″ = 0 and tried to solve for *x*, often concluding with $x > 0$ $x > 0$ so minimum.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
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